Chapter 6

Photometric observations of

Epsilon Aurigae:

International Campaign

......On the mountains of truth you can never climb in vain:
either you will reach a point higher up today, or you will be training
your powers so that you will be able to climb higher tomorrow.

... Friedrich Wilhelm Nietzsche
1. Introduction

Epsilon Aurigae (ε Aur / ε Aurigae) is a star in the constellation Aurigae. It is traditionally known as Almaaz, Haldus, or Al Anz. Epsilon Aurigae (ep-si-lon Awe-rye-gee) is a very long period eclipsing binary (Algol-like). The 27 year eclipse interval includes a nearly 2 year eclipse duration, wherein visual magnitude drops from 3.0 to 3.8. As of the SAS symposium, we’re anticipating the start of the first eclipse of the millennium during August 2009, with totality reached during December 2009, and lasting through March 2011. The end of eclipse is expected during May 2011. This will be only the fifth documented eclipse in history (Hopkins, Schanne and Stencel 2008).

The reason for the continuing interest in this binary has to do with the difficulty of determining the nature of the companion star – a dark, possibly quite massive disk shaped object, orbiting the seemingly normal F supergiant star that emits all the light.

Some of the observational questions under investigation for this eclipse include: (1) will the pre-eclipse low-amplitude light variations persist into eclipse; (2) will the beginning and depth of eclipse match prior eclipse trends indicating changes are expected; (3) will the “mid-eclipse brightening” seen during the past two eclipses recur.

Additional basic facts are receiving attention: what is the true distance to the binary? What is the physical diameter of the F supergiant star, given new interferometric diameter measurements? Can we finally decide between the high mass model for the system (15 solar mass F supergiant star primary and massive dark disk of uncertain origin) or the low mass model (a rapidly evolving post-AGB star
“phony” supergiant star with a companion shrouded by recent Roche Lobe overflow mass loss)?

Once again, epsilon Aurigae lies at the crossroads of modern astrophysics – providing evidence for high mass stellar evolution, an extreme accretion disk and possibly plan etary formation and destruction. With normal eclipsing binary star systems, one measures the brightness, changes and durations, to obtain radii, temperatures of each star in the pair. With spectroscopy, one can measure Doppler velocities, and solve for masses. This process calibrates all the important parameters that describe a star. The Vogt-Russell theorem says the mass, composition and age of a star uniquely determines the stellar structure, when normal laws of physics are applied. This procedure works well, except for epsilon Aurigae: the F supergiant star seems to have an equally massive, but invisible companion object. Thus, we have the problem of “hiding” all that mass. Numerous prior observational studies have shown the presence of additional absorptive material during eclipse. The prevailing model (Huang 1965 and thereafter) accounts for these data with a thin disk crossing the body of the F supergiant during eclipses (Carroll et al. 1991).
2. Epsilon Aurigae International Campaign 2009/2011

There is a lot of interest in epsilon Aurigae right now, and it’s been chosen as one of the key projects for the upcoming International Year of Astronomy (IYA) celebration in 2009. Because it's such a bright star, even modest equipment (including the naked eye) can provide useful information, and it will be a great way to show how everyone can contribute to scientific research. Jeff Hopkins and Robert Stencel were key organizers for the 1982-84 eclipse campaign, and are continuing their comprehensive study of this mysterious binary today. Their websites give some background on this fascinating star, and look toward what we hope to learn from observations. V data of Epsilon Aurigae during 1982 – 1984 (from Jeff Hopkins and Robert Stencel eclipse campaign) is as shown in Fig: 6.1

![Epsilon Aurigae V Data 1982 - 1984](image)

**Fig: 6.1** Epsilon Aurigae V Data 1982 – 1984

(From Jeff Hopkins and Robert Stencel eclipse campaign)
Once again, Jeff Hopkins and Robert Stencel are key organizers for ‘Epsilon Aurigae Eclipse International Campaign 2009-2011’. The J E S Observatory team is one of the members of International Campaign for this star system. In this thesis, we describe the observational efforts already underway in advance of the eclipse anticipated to begin later this year, thanks to the interest of numerous observers worldwide. The ensemble of data streams will help provide a context within which individual observations can help prove or disprove hypotheses about this mysterious system.

**Fig 6.2:** Epsilon Aurigae Star System (by Jeff Hopkins and Robert Stencel)
3. Our photometric observations of Epsilon Aurigae

This chapter consists of the observations of a very interesting eclipsing binary star system ‘Epsilon Aurigae’. We have taken Lambda Aurigae (HD 34411; V = 4.69) as a comparison star for photometric observation of Eps Aur (HD 31964; HIP 23416; HR 1605). The RA and DEC of Eps Aur are 05h 02m 39.20s and +43° 50’ 15.0” respectively. The Johnson B-V colour index of Eps Aur is 0.529. The sky map view of Eps Aur and Lam Aur as shown in fig. 6.3.

![Fig. 6.3: Eps Aur (HD 31964) with comparison star (Lam Aur) in Sky map](image-url)
Our photometric observations show good relevance with observations taken by other campaign members as shown composite graph of Eps Aur (Fig. 6.4). However our values are slightly on higher side of brightness. The detail conclusion of the eclipse of Eps Aur could be drawn after analysis of observational data at the end of eclipse.

Fig. 6.4: Composite graph of Epsilon Aurigae (2009/2011, Epsilon Aurigae Eclipse International Campaign Newsletter #16)